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# Lift and Circulation Formulas

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# List of 16 Lift and Circulation Formulas

## Lift and Circulation

### 1) Angle of Attack for Circulation developed on Airfoil

Open Calculator

fx $$\alpha = a\sin\left(\frac{\Gamma}{\pi \cdot U \cdot C}\right)$$

ex $$6.506912^\circ = a\sin\left(\frac{62\text{m}^2/\text{s}}{\pi \cdot 81\text{m/s} \cdot 2.15\text{m}}\right)$$

### 2) Angle of Attack for Lift Coefficient on Airfoil

Open Calculator

fx $$\alpha = a\sin\left(\frac{C_{\text{L airfoil}}}{2 \cdot \pi}\right)$$

ex $$6.506638^\circ = a\sin\left(\frac{0.712}{2 \cdot \pi}\right)$$

### 3) Chord Length for Circulation developed on Airfoil

Open Calculator

fx $$C = \frac{\Gamma}{\pi \cdot U \cdot \sin(\alpha)}$$

ex $$2.152276\text{m} = \frac{62\text{m}^2/\text{s}}{\pi \cdot 81\text{m/s} \cdot \sin(6.5^\circ)}$$

## 4) Circulation developed on Airfoil

Open Calculator

fx $\Gamma = \pi \cdot U \cdot C \cdot \sin(\alpha)$

ex $61.93442\text{m}^2/\text{s} = \pi \cdot 81\text{m/s} \cdot 2.15\text{m} \cdot \sin(6.5^\circ)$

## 5) Circulation for Single Stagnation Point

Open Calculator

fx $\Gamma_c = 4 \cdot \pi \cdot V_\infty \cdot R$

ex $243.1593\text{m}^2/\text{s} = 4 \cdot \pi \cdot 21.5\text{m/s} \cdot 0.9\text{m}$

## 6) Circulation in Location of Stagnation Points

Open Calculator

fx $\Gamma_c = -(\sin(\theta)) \cdot 4 \cdot \pi \cdot V_\infty \cdot R$

ex $243.1593\text{m}^2/\text{s} = -(\sin(270^\circ)) \cdot 4 \cdot \pi \cdot 21.5\text{m/s} \cdot 0.9\text{m}$

## 7) Coefficient of Lift for Airfoil

Open Calculator

fx $C_{L\ airfoil} = 2 \cdot \pi \cdot \sin(\alpha)$

ex $0.711277 = 2 \cdot \pi \cdot \sin(6.5^\circ)$

## 8) Lift coefficient for lift force in body moving on fluid

Open Calculator

fx $C_L = \dfrac{F_L{}'}{A_p \cdot 0.5 \cdot \rho \cdot (v^2)}$

ex $0.944451 = \dfrac{1100\text{N}}{1.88\text{m}^2 \cdot 0.5 \cdot 1.21\text{kg/m}^3 \cdot \left((32\text{m/s})^2\right)}$

## 9) Lift Coefficient for Rotating Cylinder with Circulation

Open Calculator

fx $$C' = \frac{\Gamma_c}{R \cdot V_\infty}$$

ex $$12.55814 = \frac{243\text{m}^2/\text{s}}{0.9\text{m} \cdot 21.5\text{m/s}}$$

## 10) Lift Coefficient for Rotating Cylinder with Tangential Speed

Open Calculator

fx $$C' = \frac{2 \cdot \pi \cdot v_t}{V_\infty}$$

ex $$12.56637 = \frac{2 \cdot \pi \cdot 43\text{m/s}}{21.5\text{m/s}}$$

## 11) Lift Force for Body moving in Fluid

Open Calculator

fx $$(F_L') = \frac{C_L \cdot A_p \cdot M_w \cdot \left(v^2\right)}{V_w \cdot 2}$$

ex $$1098.693\text{N} = \frac{0.94 \cdot 1.88\text{m}^2 \cdot 3.4\text{kg} \cdot \left((32\text{m/s})^2\right)}{2.8\text{m}^3 \cdot 2}$$

## 12) Lift Force for body moving in Fluid of Certain Density

Open Calculator

fx $$F_L = C_L \cdot A_p \cdot \rho \cdot \frac{v^2}{2}$$

ex $$1094.816\text{N} = 0.94 \cdot 1.88\text{m}^2 \cdot 1.21\text{kg/m}^3 \cdot \frac{(32\text{m/s})^2}{2}$$

## 13) Lift Force on Cylinder for Circulation

Open Calculator

$$F_L = \rho \cdot I \cdot \Gamma_c \cdot V_\infty$$

$$53733.98\text{N} = 1.21\text{kg/m}^3 \cdot 8.5\text{m} \cdot 243\text{m}^2\text{/s} \cdot 21.5\text{m/s}$$

## 14) Radius of Cylinder for Lift Coefficient in Rotating Cylinder with Circulation

Open Calculator

$$R = \frac{\Gamma_c}{C' \cdot V_\infty}$$

$$0.900584\text{m} = \frac{243\text{m}^2\text{/s}}{12.55 \cdot 21.5\text{m/s}}$$

## 15) Tangential Velocity of Cylinder with Lift Coefficient

Open Calculator

$$v_t = \frac{C' \cdot V_\infty}{2 \cdot \pi}$$

$$42.94398\text{m/s} = \frac{12.55 \cdot 21.5\text{m/s}}{2 \cdot \pi}$$

## 16) Velocity of Airfoil for Circulation developed on Airfoil

Open Calculator

$$U = \frac{\Gamma}{\pi \cdot C \cdot \sin(\alpha)}$$

$$81.08576\text{m/s} = \frac{62\text{m}^2\text{/s}}{\pi \cdot 2.15\text{m} \cdot \sin(6.5^\circ)}$$

# Variables Used

- $A_p$ Projected Area of Body *(Square Meter)*
- $C$ Chord Length of Airfoil *(Meter)*
- $C_{L\ airfoil}$ Lift Coefficient for Airfoil
- $C_L$ Lift Coefficient for Body in Fluid
- $C'$ Lift Coefficient for Rotating Cylinder
- $F_L$ Lift Force on Rotating Cylinder *(Newton)*
- $F_L'$ Lift Force on Body in Fluid *(Newton)*
- $l$ Length of Cylinder in Fluid Flow *(Meter)*
- $M_w$ Mass of Flowing Fluid *(Kilogram)*
- $R$ Radius of Rotating Cylinder *(Meter)*
- $U$ Velocity of Airfoil *(Meter per Second)*
- $v$ Velocity of Body or Fluid *(Meter per Second)*
- $V_\infty$ Freestream Velocity of Fluid *(Meter per Second)*
- $v_t$ Tangential Velocity of Cylinder in Fluid *(Meter per Second)*
- $V_w$ Volume of Flowing Fluid *(Cubic Meter)*
- $\alpha$ Angle of Attack on Airfoil *(Degree)*
- $\Gamma$ Circulation on Airfoil *(Square Meter per Second)*
- $\Gamma_c$ Circulation Around Cylinder *(Square Meter per Second)*
- $\theta$ Angle at Stagnation Point *(Degree)*
- $\rho$ Density of Fluid Circulating *(Kilogram per Cubic Meter)*

# Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  *Archimedes' constant*
- Function: **asin**, asin(Number)
  *The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.*
- Function: **sin**, sin(Angle)
  *Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.*
- Measurement: **Length** in Meter (m)
  *Length Unit Conversion*
- Measurement: **Weight** in Kilogram (kg)
  *Weight Unit Conversion*
- Measurement: **Volume** in Cubic Meter ($m^3$)
  *Volume Unit Conversion*
- Measurement: **Area** in Square Meter ($m^2$)
  *Area Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s)
  *Speed Unit Conversion*
- Measurement: **Force** in Newton (N)
  *Force Unit Conversion*
- Measurement: **Angle** in Degree (°)
  *Angle Unit Conversion*
- Measurement: **Density** in Kilogram per Cubic Meter ($kg/m^3$)
  *Density Unit Conversion*

- Measurement: **Momentum Diffusivity** in Square Meter per Second (m²/s)
  *Momentum Diffusivity Unit Conversion*

## Check other formula lists

- **Drag and Forces Formulas**
- **Lift and Circulation Formulas**

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